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Power Switching Semi-conductor Devices including Rectifying Junction Shunts

Provides superior power switching capabilities in Power MOSFETs; enables smaller area JBS or SIR diodes, and optimized PiN diodes for speed

Description

This semiconductor device integrates reverse conducting SIR junction shunts into a Power MOSFET (metal oxide semiconductor field-effect transistor) to produce a superior power switching device. It provides several critical advantages for JBS, SIR and PiN diodes. This SIR junction shunt prevents the internal drain-body junction from injecting majority carriers which would normally lead to slow recovery and crystal degradation. It also enables the current to flow for voltages lower that the drain-body thus providing lower on-state losses than a PiN diode at lower current range conditions. This system is also effective at preventing forward bias in internal PiN diodes. If paralleled with an external PIN, JBS or SIR diode, the system provides high total diode current capability, and permits the use of smaller area (lower capacitance) JBS or SIR diodes or PiN diodes optimized for speed.

NOTE: a Patent Cooperation Treaty was filed on Dec. 1, 2007.

Applications

- **Power supply and converters**
  Improved low-voltage power switch

Advantages

- **Prevents crystal degradation and slow reverse recovery**
  Bypasses current flow from the inherent internal drain-body junction preventing it from injecting majority carriers
- **Greater efficiency**
  Provides lower on-state losses at lower current range conditions

Abstract

Typical applications for switching power devices (e.g., IGBT or Power MOSFET) require reverse conduction for rectification or clamping by either an internal or external diode. Because Power MOSFETs have an inherent PiN diode within the structure, this internal diode must either be made to work effetely for the rectification and clamping, or must be bypassed by an external diode. Because the inherent internal PiN diode results in majority carrier injection from the drain-body

junction (PN junction at Body-to-Drift-Layer interface) it has slow reverse recovery time and may result in SiC crystal degradation. The concept of inclusion of reverse conducting SIR junction shunts provides substantial benefits by: 1) bypassing current flow from the inherent internal drain-body junction preventing it from injecting majority carriers and thus preventing slow reverse recovery and crystal degradation, and 2) enabling current to flow for voltages lower than the drain-body junction built in potential (e.g., approximately 3 V for SiC) and thus provides lower on-state losses than a PiN diode for the lower current range condition.

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Citations

1. A.D. Chijioke, J.R. Lawall, Laser doppler vibrometer eploying active frequency feedback, Appliet optics 47 (2008)

References

- U.S. Patent #7,598,567
- Docket: 06-008

Status of Availability

This invention is available for licensing.

Last Modified: 09/11/2011